

# A Can of Bull?

## Do Energy Drinks Really Provide a Source of Energy?



by

Merle Heidemann, Division of Science and Mathematics Education, Michigan State University

Gerald Urquhart, Lyman Briggs School of Science, Michigan State University

---

### Objectives

- Describe and categorize chemically the components of various popular “energy drinks.”
- Determine the physiological role of these components in the human body.
- Explain scientifically how the marketing claims for these drinks are supported (or not).
- Determine under what conditions each of the “energy drinks” might be useful to the consumer.

### The Case

After spending several years working the Sport’s Desk of the *Lansing State Journal*, Rhonda had landed the job of her dreams as a writer for *Runners’ World* magazine. The job was fantastic! Since high school, where she had excelled in cross country, Rhonda had been a consistent runner, participating in local races and those assigned to her for her job. For her last assignment, she had run and reported on the Leadwood, South Dakota, marathon—it was a blast!

As if reading her mind, her boss Charley walked in just then with a can of XS Citrus Blast® in one hand and a list of several other energy drinks in the other.

“We’ve been getting a lot of inquiries about the different energy drinks on the market, including XS Citrus Blast®. Do you know anything about them?” Charley asked.

“I know that people use them for various reasons,” replied Rhonda. “It seems they’re primarily used by athletes to provide some ‘fuel’ as they practice and compete. Other people use them more casually as a way to become ‘energized.’ That’s about all I know.”

“That seems to be about all any of us knows,” Charley said.

“For your next assignment,” Charley continued, “I want you to find out what each of the ingredients in these drinks is and what it does for a runner or for a non-athlete. You need to be very accurate in your analysis—determine what each component really does for the body, not what the marketers want you to believe it does. Then look at the marketing claims of some of these drinks and see if the scientific facts match up to them. Many of our readers are using these drinks with some general notion that they’re helpful, but they’re basing their use of them on no scientific information. I’ve got the marketing claims, a list of ingredients and nutrition facts provided on the cans for consumers, and a short list of questions that should get you started. When you research these, be sure to document all your sources of information, keeping in mind that all resources are not equal. Here’s the information.”

---

With that, Charley left the office. Rhonda looked over the list. “Guess I’ll have to brush up on my biochemistry. No problem. I’m interested in knowing if my running would be improved by drinking this stuff.”

Rhonda recalled that a food’s calorie content was the simplest reflection of its energy content. Looking at Charley’s list she saw that the different energy drinks contained the following *numbers of calories*:

<b>Energy Drink</b>	<b>Calories:</b>
<i>XS Citrus Blast</i> <sup>®</sup>	8
<i>Red Bull</i> <sup>®</sup>	110
<i>Sobe Adrenaline Rush</i> <sup>®</sup>	140
<i>Impulse</i> <sup>®</sup>	110
<b>For comparison:</b>	
<i>Coca Cola</i> <sup>®</sup> (12 oz)	140



## Marketing Claims

Next, Rhonda perused the marketing claims for each drink:

### *Red Bull®*

- The Red Bull energy drink is a functional product developed especially for periods of increased mental and physical exertion.
- It can be drunk in virtually any situation: at sport, work, study, driving and socializing.
- Improves performance, especially during times of increased stress or strain.
- Improves concentration and reaction speed.
- Stimulates the metabolism.

### *XS Citrus Blast®*

- There is less than 1/2 calorie of sugar in XS Citrus Blast. This qualifies for the government-approved statement “No Sugar.” The 8 calories in XS Citrus Blast are from amino acids and are protein calories that aid your body’s natural metabolic process.
- Most 8-ounce energy drinks in the market today have over 100 calories and from 27 to 30 grams of sugar, which is a simple carbohydrate. Most 12-ounce non-diet soft drinks have 170 calories from 40 grams of sugar. Most 5.5-ounce juice drinks have 80 calories from 20 grams of sugar.
- Calories from sugar and carbohydrates may increase fat deposits. Simple carbohydrates are also called high glycemic (high sugar) foods. High glycemic foods cause your body to pump insulin to digest the sugar, which sends a message to your body to store calories as fat. Low glycemic foods do not pump insulin to the same degree and aid in your body’s natural metabolism of fat, using your body’s fat resources as fuel. Many experts fear that the epidemic incidence of diabetes in North America today may be significantly contributed to by high-glycemic diets. The 8 calories in XS Citrus Blast are from amino acids and are protein calories that aid your body’s natural metabolic process.
- XS Citrus Blast uses a proprietary blend of Sucralose, Acesulfame Potassium (Ace K), and fruit essences to give the drinks their great flavor without sugar or empty calories. In fact, the 8 calories in the drink come from the 2 grams of amino acids, which are protein calories.

### *Sobe Adrenaline Rush®*

- This maximum energy supplement delivers an energy boost with a natural passion fruit flavor. It’s lightly carbonated with a clean smooth feel.
- This maximum energy supplement is fortified with a unique blend of natural energizing elements, including d-ribose, l-carnitine and taurine. It’s pure, concentrated energy in an 8.3-fluid-ounce can.

### *Impulse®*

- Elevate Your Performance
- Impulse Energy Drink contains special supplements to immediately enhance mental and physical efficiency and give you the energy boost you deserve... replenishing your strength.
- Impulse gets its energy from a simple source: nutrients, minerals, and vitamins that occur naturally in the body and foods we eat. Enjoy: the wake-up power of caffeine, the alertness-inducing properties of taurine, the lift you get from vitamins B6 and B12. Combined with Impulse’s other ingredients, these are known to increase mental focus and physical well being, enhance performance, and accelerate metabolism.



## Charley's List of Questions

Rhonda realized that before she could start analyzing the energy drinks, she needed to know the answer to the following question:

*When we say that something gives us “energy,” what does that mean? What is a biological definition of energy?*

After satisfying herself that she had a good definition, she turned to the first set of questions on Charley's list.

1. What is the nature (sugar, amino acid, vitamin, etc.) of each ingredient listed on the cans?
2. What is the physiological role of each in the human body?
3. Which ingredients provide energy?
4. Which ingredients contribute to body repair, i.e., which help build or rebuild muscle tissue?

Rhonda was determined to wade through the confusing labeling of the drinks. For example, XS Citrus Blast® boasted that it had no calories but still provided “energy.” That made absolutely no sense based on what Rhonda knew about biological energy! The first thing she needed to do was sort out the various ingredients on the labels—a task that consumers rarely undertake.



## Ingredients & Nutrition Facts

As in most labels, listed in order of mass in drinks (highest to lowest).

### *XS Citrus Blast*<sup>®</sup>

- *Ingredients:* carbonated water, l-aurine, l-glutamine, citric acid, adaptogen blend (eleutherococcus senticosus, panax ginseng, panax quinquefolium, echinacea purpurea, schisandra, astragalus, and reishi), natural flavors, acesulfame potassium, caffeine, sodium benzoate, potassium sorbate, sucralose, niacin, pantothenic acid, pyridoxine HCL, yellow 5, cyanocobalamin
- *Nutrition Facts:* serving size: 8.4 fl oz; servings per container: 1; calories: 8; fat: 0g; sodium: 24mg; potassium: 25mg; total carbs: 0g; sugars: 0g; protein: 2g; vitamin B3: 100%; vitamin B6: 300%; vitamin B5: 100%; vitamin B12: 4900%

### *Red Bull*<sup>®</sup>

- *Ingredients:* carbonated water, sucrose, glucose, sodium citrate, taurine, glucuronolactone, caffeine, inositol, niacin, D-pantothenol, pyridoxine HCL, vitamin B12, artificial flavors, colors
- *Nutrition Facts:* serving size: 8.3 fl oz; servings per container: 1; amount per serving: calories: 110; total fat: 0g; sodium: 200mg; protein: 0g; total carbohydrates: 28g; sugars: 27g

### *Sobe Adrenaline Rush*<sup>®</sup>

- *Ingredients:* filtered water, high fructose corn syrup, citric acid, taurine, d-ribose, l-carnitine, natural flavor, inositol, sodium citrate, ascorbic acid, caffeine, monopotassium phosphate, salt, gum arabic, ester gum, siberian ginseng root extract, pyridoxine hydrochloride, guarana seed extract, caramel color, beta-carotene, folic acid, cyanocobalamin
- *Nutrition Facts:* serving size: 8.3 fl oz; servings per container: 1; amount per serving: calories: 140; total fat: 0g; sodium: 60mg; protein: 1g; total carbohydrates: 36g; sugars: 34g; taurine: 1000mg; d-ribose: 500mg; l-carnitine: 250mg; inositol: 100mg; siberian ginseng: 50mg; guarana: 50mg

### *Impulse*<sup>®</sup>

- *Ingredients:* carbonated water, sucrose, taurine, glucuronolactone, caffeine, inositol, niacinimide, pyridoxine HCL, vitamin C (citric acid), vitamin B12, artificial flavors, colors
- *Nutrition Facts:* serving size: 8.3 fl oz; servings per container: 1; calories: 110; fat: 0g; sodium: 200mg; total carbs: 28g; sugars: 27g; protein: 1g; niacin: 100%; vitamin B6: 250%; vitamin B12: 80%; pantothenic acid: 50%; vitamin C: 100%

### *Coca Cola*<sup>®</sup> (for later comparison)

- *Ingredients:* carbonated water, high fructose corn syrup and/or sucrose, phosphoric acid, natural flavors, caffeine
- *Nutrition Facts:* serving size: 12 fl oz; servings per container: 1; calories: 140; fat: 0g; total carbs: 38g; sugars: 38 g; protein: 0 g



## Biochemical Information

### Acesulfame Potassium (Sunett)

- *Chemical formula:*  $C_4H_4KNO_4S$
- *What it is:* Simple ring structure that resembles glucose
- *What it does:* Artificial sweetener to provide taste.

### Aspartame

- *Chemical formula:*  $C_{14}H_{18}N_2O_5$
- *What it is:* Dipeptide
- *What it does:* Low calorie artificial sweetener that provides taste.

### Caffeine

- *Chemical formula:*  $C_8H_{10}N_4O_2$
- *What it is:* One of the most widely used psychoactive substances in the world. Caffeine is a mild CNS stimulant with a transient effect that usually passes within a few hours but varies between individuals.
- *What it does:* Some studies have shown that caffeine may improve memory and reasoning responses on tests; other studies have shown that ingesting 3-9mg of caffeine one hour before physical activity improves endurance running and cycling in athletes. No adverse effects in humans have been documented.

### Citric Acid

- *Chemical formula:*  $C_6H_8O_7$
- *What it is:* Organic acid
- *What it does:* It is a precursor for the citric acid cycle (Kreb's Cycle), which is a major pathway in the cell's production of chemical energy.

### Cyanocobalamin

- *Chemical formula:*  $C_{63}H_{88}CoN_{14}O_{14}P$
- *What it is:* Synthetic form of Vitamin B-12
- *What it does:* Important for growth, cell reproduction, blood formation, and protein and tissue synthesis.

### Folic Acid

- *Chemical formula:*  $C_{19}H_{19}N_7O_6$
- *What it is:* Vitamin
- *What it does:* Required for metabolism of carbon compounds, nucleic acids, and amino acids.

### Fructose

- *Chemical formula:*  $C_6H_{12}O_6$
- *What it is:* Simple sugar
- *What it does:* Can be converted into a form for entry into the primary metabolic pathway in which the chemical energy of its bonds is converted into ATP, the primary "energy" molecule in the body.

### Glucose

- *Chemical formula:*  $C_6H_{12}O_6$
- *What it is:* Simple sugar
- *What it does:* Enters the primary metabolic pathway in which the chemical energy of its bonds is converted into ATP, the primary "energy" molecule in the body.

## Glucuronolactone

- *Chemical formula:*  $C_6H_6O_6$
- *What it is:* Simple saccharide (sugar)
- *What it does:* It is a normal human metabolic byproduct formed from glucose. Glucuronolactone is found in connective tissue in animals. Also regulates formation of glycogen. Small amounts shouldn't be harmful.

## 1-Glutamine

- *Chemical formula:*  $C_5H_{10}N_2O_3$
- *What it is:* Amino acid
- *What it does:* Aids in muscle building and maintenance.

## Inositol

- *Chemical formula:*  $C_6H_6(OH)_6$
- *What it is:* A sugar that is a member of the Vitamin B complex
- *What it does:* Controls cholesterol levels and has potential antioxidant capabilities.

## Niacin (nicotinic acid)

- *Chemical formula:*  $C_6H_5NO_2$
- *What it is:* Water soluble vitamin
- *What it does:* Derivatives such as NADH are required for metabolism. It is said to aid in the synthesis of amino acids, the subunits of proteins. It has not been directly linked to improving athletic performance.

## Niacinamide

- *Chemical formula:*  $C_6H_6N_2O$
- *What it is:* Water soluble vitamin
- *What it does:* See niacin above; both are components of the coenzymes NAD and NADP, important in the redox reactions of metabolism.

## Pantothenic Acid (also known as D-pantothenol)

- *Chemical formula:*  $C_9H_{17}O_5N$
- *What it is:* Synthetic form of Vitamin B-5
- *What it does:* Precursor of coenzyme A. Helps you use fats and carbohydrates to make molecules used for energy. Is involved in more than 100 different metabolic pathways including energy metabolism of carbohydrates, proteins and lipids, and the synthesis of lipids, neurotransmitters, steroid hormones, porphyrins, and hemoglobin. It's found in a wide array of energy drinks and supplements, but its toxicity has not been evaluated.

## Potassium sorbate

- *Chemical formula:*  $C_6H_8O_2$
- *What it is:* Potassium salt of sorbic acid
- *What it does:* Used to inhibit fungal growth in foods.

## Pyridoxine HCL

- *Chemical formula:*  $C_8H_{11}NO_3$
- *What it is:* Synthetic form of Vitamin B-6
- *What it does:* Energy production, efficient metabolic functioning, protein digestion, as well as maintaining healthy nervous system, skin, hair and nails. The B-compound vitamins are probably the single most important set of factors needed for proper maintenance of the nervous system as well as proper functioning of the cell and its energy metabolism.

### **Sucralose (splenda)**

- *Chemical formula:*  $C_{12}H_{19}O_8Cl_3$
- *What it is:* Derivative of sucrose
- *What it does:* Artificial sweetener to provide taste.

### **Sucrose**

- *Chemical formula:*  $C_{12}H_{22}O_{11}$
- *What it is:* Simple sugar
- *What it does:* Can be converted into a form for entry into the primary metabolic pathway in which the chemical energy of its bonds is converted into ATP, the primary “energy” molecule in the body.

### **1-Taurine**

- *Chemical formula:*  $C_2H_7NO_3S$
- *What it is:* A non-essential amino acid
- *What it does:* Improved reaction time, concentration, and memory (not proven); essential amino acid for cats.

### **Water**

- *Chemical formula:*  $H_2O$
- *What it is:* A solvent for the other ingredients
- *What it does:* Essential for physiological processes.



## Your Task

Research each ingredient found in these energy drinks. This information can be found in biochemistry and nutrition textbooks. Web sources may provide valuable information, but be critical in their use. Many will make unsubstantiated claims. One that can get you started for basic information is

<http://www.chemindustry.com>. Basic information can also be garnered from <http://www.usda.gov/wps/portal/usdahome>—click on the “Food and Nutrition” link.

Determine the chemical structure, the type of chemical each is, and the physiological role played by each compound. You should have sufficient information to answer Charley’s list of questions as well as the additional questions listed below. Fill out the table and answer the questions. Please cite any websites that you used in your analysis.

## Post Research Analysis

Using the information that your group gathered, place each of the ingredients for your drink under the proper heading in the table below.

Sources of Energy	Amino Acids	Stimulants and Vitamins	Other—please categorize

## Questions

1. When we say that something gives us “energy,” what does that mean? What is a biological definition of energy?
2. What is the physiological role of each of the molecules in your table?
  - a. Which ingredients provide energy? How do they do that?
  - b. Which ingredients contribute to body repair, i.e., which help build or rebuild muscle tissue?
3. In what ways might the one(s) that does (do) not have a metabolic energy source (caffeine) provide the perception of increased energy after consumption?
4. How are the ingredients in these drinks helpful to someone expending a lot of energy, e.g., a runner?
5. Does your analysis substantiate the claim that this is an “energy drink”? If so, what molecules are the sources of energy?
6. Could your drink serve different purposes for different consumers? Explain.
7. What is the normal physiological response to increased intake of sugars? to increased intake of caffeine?
8. Is there such a thing as a “sugar high”? Explain your answer.
9. Evaluate, in terms of basic physiology and biochemistry, the statement: A lack of sleep causes a lack of energy.
10. Are the product claims legitimate? Why?
11. Should you simply buy a can of Coke® rather than one of these energy drinks? Why/why not?

## Assessment

Individually, or as a group, write an evaluation of the marketing claims for your drink. You may write the evaluation in the form of an article for readers of Runner’s World. Be sure to include answers to the questions above.